TOPIC 05 – ENERGETICS

5.3: HESS'S LAW

IB Chemistry

T05D05

5.3 Hess's law - 2 hours

- 5.3.1 Determine the enthalpy change of a reaction that is the sum of two or three reactions with known enthalpy changes. (3)

5.3 - Enthalpy

- Remember, **enthalpy** is the potential energy stored in chemical bonds and is given the symbol, **H**. The change in energy is **ΔH** and is expressed in the following equation:

$$\Delta H = H_{products} - H_{reactants}$$

- **Hess's** law states that if a reaction consists of a number of steps, the overall enthalpy change is equal to the sum of the enthalpy changes for all the individual steps
- **Hess's** law states that the overall enthalpy change in a reaction is constant and not dependent on the pathway taken.

5.3 – Enthalpy of Reaction

- For the following reaction, if we want to know the enthalpy of reaction we must find the value for the breaking or forming of each of the substances involved

$$N_2\,(g) \;+\; \tfrac{1}{2}\,O_2\,(g) \;\rightarrow\; N_2O\,(g)$$

  - Values for diatomic molecules $\Delta H^o = 0$ kJ/mol
  - $N_2O_{(g)} = +81.60$ kJ/mol
- $\Delta H = H_{products} - H_{reactants} = (81.60 \text{ kJ/mol} - 0 \text{ kJ/mol})$

  $= \mathbf{+81.60\ kJ/mol}$

5.3 – Enthalpy of Reverse Reaction

- What about the reverse reaction?

$$N_2O\ (g) \rightarrow N_2\ (g) + \tfrac{1}{2}\ O_2\ (g)$$

  - Values for diatomic molecules $\Delta H^o = 0$ kJ/mol
  - $N_2O_{(g)} = +81.60$ kJ/mol
- $\Delta H = H_{products} - H_{reactants} = (0 \text{ kJ/mol} - 81.60 \text{ kJ/mol})$

$$= \mathbf{-81.60\ kJ/mol}$$

- You find that the value is equal and opposite

5.3 – Enthalpy of Multiples

- Try a multiple of the same reaction

$$2N_2\,(g) + O_2\,(g) \rightarrow 2\,N_2O\,(g)$$

  - Values for diatomic molecules $\Delta H^o = 0$ kJ/mol
  - $N_2O_{(g)} = +81.60$ kJ/mol
- $\Delta H = H_{products} - H_{reactants} = ((2 \times 81.60 \text{ kJ/mol}) - 0 \text{ kJ/mol})$

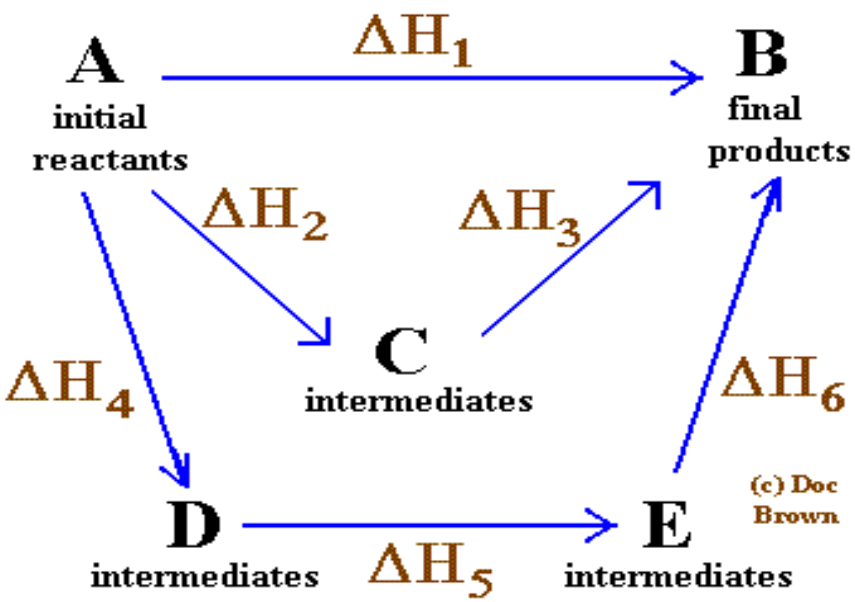
$$= \mathbf{+163.2\ kJ/mol}$$

5.3 – Rules for Enthalpy Calcs

1. If you multiply the reaction, you must also multiply the ΔH values
2. The value of enthalpy, ΔH, of a reaction is negative, $-\Delta H$, for the reverse reaction

5.3 – Hess's Law

- If we know information about various steps (equations), we instead use Hess's law which gives us the same result via a different method
- In the example below, for the reaction A → B
  - $\Delta H_1 = \Delta H_2 + \Delta H_3$
  - $\Delta H_1 = \Delta H_4 + \Delta H_5 + \Delta H_6$



5.3 – Hess's Law